Acute Thrombo-Embolic Occlusion of the Superior Mesenteric Artery: a Prospective Study in a Well Defined Population

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Objectives: to characterize the clinical presentation of patients with acute thrombo-embolic occlusion of the superior mesenteric artery (SMA).

Design: prospective study.

Materials: twenty-four consecutive patients admitted to Blekinge County Hospital, Karlskrona, Sweden, with acute thrombo-embolic occlusion of the SMA, over a three-year period from April 1999 through March 2002.

Methods: clinical data were registered prospectively. Incidence, diagnostic procedures and factors associated with survival were analysed.

Results: the diagnosis was verified at operation in 20, and at autopsy in 4 patients. The incidence was 5.3 per 100 000 inhabitants per year. Among the 20 patients with embolic disease, atrial fibrillation was present in 95%, synchronous embolic events in 30% and warfarin treatment in 10%. D-dimer was elevated on admission in 13/13. Four patients were diagnosed at first consultation. Fifteen underwent curative revascularisation (6) or bowel resection only (9). Five were alive at one-year follow-up, of whom one had short bowel syndrome. Length of bowel ischaemia predicted institutional (p = 0.004) and one-year mortality (p = 0.005).

Conclusions: the incidence was higher than expected. Embolic occlusions predominated. Old age, atrial fibrillation, severe abdominal pain and synchronous embolus suggest the diagnosis of acute bowel ischaemia. Length of bowel ischaemia predicted outcome.

Key Words: Superior mesenteric artery; Thrombo-embolism; Bowel ischaemia.

Introduction

Patients with acute bowel ischaemia, and particularly thrombo-embolic occlusive disease of the superior mesenteric artery (SMA), remain a challenge to the surgical community, despite advances in radiological and operating techniques, anaesthesia and postoperative care. Prognosis is poor and a recent study reported an institutional mortality of 83%. Furthermore, they did not find that clinical features, serum markers or radiological investigations were helpful in making the diagnosis.1 Nevertheless, acute SMA occlusion should be considered when the following clinical triad exists: (1) Abdominal pain that is “out of proportion” to the signs. (2) Vomiting and/or diarrhoea, sometimes bloody. (3) Obvious source of embolus such as atrial fibrillation (AF) or recent myocardial infarction (MI).2 Explorative laparotomy remains the gold standard as far as diagnosis is concerned and is the only way to evaluate the extent of the ischaemic lesion. The aim of this study was to prospectively characterise the clinical presentation, treatment and outcome of an unselected cohort of patients with acute thrombo-embolic occlusion of the SMA.

Patients and Methods

Between April 1999 and March 2002, consecutive patients admitted with verified or clinically suspected bowel ischaemia, were prospectively registered. Of these, only patients with acute thrombo-embolic occlusion of the SMA, verified either by operation or autopsy, were included in the study. Medical history, symptoms and signs on presentation, delay from onset and presentation to intervention, laboratory tests, electrocardiogram (ECG), radiological and endoscopic investigations, operations, postoperative course and follow-up were recorded prospectively. The distinction between an embolic and a thrombotic
occlusion may be difficult. If a synchronous embolus at another location was present, we defined the embolism as “certain”. If an embolic cardiac source was present, we defined the embolic occlusion as “probable”. An occlusion was defined as probably thrombotic based on the evaluation of the vascular surgeon performing the revascularisation procedure or on the lack of an embolic source. The length of ischaemic bowel was estimated clinically from examination of its serosal aspect. All autopsies with main or secondary diagnosis of “bowel ischaemia,” “bowel necrosis” or “peritonitis” were identified from a prospectively gathered Department of Pathology database and examined. When evaluating prognostic factors for survival we used the non-parametric Mann-Whitney U-test, since both age and bowel ischaemia length had a negatively skewed distribution. A p-value <0.05 was considered significant.

Results

Twenty patients were diagnosed at operation and four at autopsy. The following patients had bowel ischaemia verified at surgery, mesenteric angiography or autopsy but were excluded from the study: chronic bowel ischaemia (n = 6), non-occlusive bowel ischaemia due to low cardiac output or multiple organic failure (n = 7), ischaemic colitis (n = 2), colon ischaemia after operation for ruptured aortoiliac aneurysm (n = 2) and mesenteric venous thrombosis (n = 3). Two patients, 91 and 94 years of age, died of a suspected acute bowel ischaemia, but autopsy was not performed. During the study period 5193 people died in Blekinge, a county with a population of 150 000 (Swedish Central Bureau of Statistics). Autopsies were performed on 527 patients giving a county autopsy frequency of 10.1%. The incidence of verified acute thrombo-embolic occlusion of the SMA was 5.3 per 100 000 inhabitants per year. Twenty patients were considered to have an embolic occlusion of the SMA; six with certain emboli and 14 with probable emboli. Four patients were considered to have a probable thrombotic occlusion.

Clinical presentation

The median age was 83.5 (range 63–96) years. There were 16 women, median age 86.5 (range 63–96) years and eight men, median age 76 (range 70–88) years. Past medical history and vasoactive medications are shown in Table 1. Vomiting, diarrhoea and haemorrhage occurred in 71, 42 and 21%, respectively. Twelve patients (50%) suffered from a sudden onset (within minutes), seven (29%) developed acute (within 1 h) and five (21%) had an insidious onset of abdominal pain. Thirteen patients had morphine-resistant and eleven a moderate intensity of pain at admission. The median length of ischaemic bowel was 3.4 m (range 0.5–4.3 m). Ninety-five per cent of patients with embolic disease had AF, 80% had clinical triad referred to in the introduction and 10% had acute MI. Synchronous emboli occurred in six patients, of whom four were diagnosed peri-operatively (three cerebral, one femoral). Two patients were on warfarin, one of whom had a sub-therapeutic INR on admission. At presentation, half of the patients had reported symptoms for less than 4 h (range 0–168 h). Occlusion of the SMA was suspected at first consultation in four patients, two of whom survived. It took a median of 5 h (range 2–8 h) before these patients underwent laparotomy. The other 20 patients were evaluated by a total of 48 doctors at their first consultation, of whom 23 were surgical specialists. Sixteen of these patients had to wait a median of 33 h (range 8–188 h) for diagnostic laparotomy, and four patients were diagnosed post-mortem. In one case laparotomy was performed 4 h after admission, but ischaemic bowel was not diagnosed. However, it was diagnosed at re-laparotomy after 184 h later. Five cases were correctly diagnosed before operation after diagnostic work-up.

Patient flow and autopsies

A quarter of the patients were not under the care of a surgeon after the first consultation. There was a significant interchange of patients between the wards of surgery, internal medicine and infectious diseases (Fig. 1). Four patients were diagnosed by autopsy; three presented themselves late, 48–96 h after onset of symptoms. Two patients were hospitalised in non-surgical wards, where death took place. One

Table 1. Medical history and medication in the 24 patients.

<table>
<thead>
<tr>
<th>Medical history</th>
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<tbody>
<tr>
<td>Atrial fibrillation</td>
<td>19 (79)</td>
</tr>
<tr>
<td>Previous CVI</td>
<td>12 (50)</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>12 (50)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>9 (38)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Betareceptor antagonist or digitalis</td>
<td>17 (71)</td>
</tr>
<tr>
<td>Acetylsalicylic acid</td>
<td>11 (46)</td>
</tr>
<tr>
<td>Warfarin</td>
<td>2 (8)</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages.
diagnostic autopsy showed four embolic localizations (SMA, groin, spleen and kidney). In two of the four patients diagnosed at post-mortem the diagnosis was suspected by the clinician.

**Investigations**

Leucocytes and lactate dehydrogenase (LD) were both elevated in 83% on admission, whereas the median value of CRP was only slightly raised at 18 mg/L (Table 2). D-dimer was elevated in all (13/13) cases with a median value of 2.4 mg/L (reference value <0.3). Twelve patients had arterial blood-gas analysis; five had alkalosis and three had acidosis. Four patients had a metabolic alkalosis, of whom three had been vomiting. Metabolic and respiratory acidosis occurred in two and one case, respectively. None of the radiological and endoscopic evaluations (plain abdominal X-ray (n = 17), CT abdomen (7), ultrasound abdomen (8), duplex of the SMA (1), barium enema (1), gastroscopy (4) and rectoscopy (3)) were diagnostic. Plain abdominal X-ray was normal in ten, showed paralytic ileus in five and intestinal obstruction in two patients. CT scans were performed with (n = 1) or without (n = 6) intravenous contrast enhancement. The one duplex examination showed normal flow in the proximal SMA.

**The operations**

Twenty patients were operated, of whom five underwent exploratory laparotomy only. Eighteen patients were diagnosed with laparotomy and two with laparoscopy. Six patients (median age 85.5 years) underwent revascularization of the SMA: embolectomy (n = 4) and thrombectomy (n = 2). Among these six patients, the median time between onset of symptoms and laparotomy/laparoscopy was 23 h (range 3.5–74).

Two were suspected of having an occlusive disease of the SMA at first consultation. Revascularisation was accompanied by bowel resection in five patients. A second-look laparotomy was performed in three, one of whom required additional bowel resection. Nine patients underwent primary bowel resection only. Two second-look procedures and one third-look were performed: One patient had a second-look with bowel resection after a negative explorative laparotomy. The other second-look with enteroscopy was uneventful, but third-look resulted in diverting stomas due to anastomotic leakage. The operative procedures and outcome are specified in Fig. 2. The median bowel resection length among patients undergoing curative surgery (n = 15) was 1.3 m (range 0–3.7 m) small intestine and 0.1 m (range 0–0.4 m) colon. The bowel resections were followed by primary anastomosis in 11 patients and diverting stomas in four patients.

**Postoperative course**

Fifteen patients received either Fragmin (anti-Xa) 5000 IE twice a day (n = 14) or Heparin (heparin) intravenously in full dosage (n = 1). One successful femoral thrombolysis was performed. Trans-thoracic echocardiography was performed on four patients but no cardiac thrombus was seen. Infectious problems occurred in ten patients: three pneumonias, four wound infections, three urinary infections, two fungal and one bacterial septicemias. Of the nine patients who were discharged, five received warfarin and three aspirin. Among the 15 non-survivors the primary cause of death was considered to be bowel infarction (n = 13), multiple organ failure (n = 1) and heart failure/pneumonia (n = 1).

**Follow-up**

Nine patients were discharged (median age 74.5, range 70–89 years), of whom four died within one year due to septicemia and short bowel syndrome (SBS), multiple organ failure and SBS, heart failure and SBS and suspected bowel ischaemia, respectively. Four of the five patients were doing well at one-year follow-up. These five patients had a median bowel resection length of 1.2 m (range 0.5–2.7 m). Two of these patients had transient SBS. In one patient the diverting stomas were anastomosed three months after the first operation, eliminating SBS within one year. One patient was considered unfit for re-operation: he lived with diverting stomas, was dependent on
intravenous nutritional support and died 1.5 years postoperatively. The median follow-up time for the four survivors was 1.8 years (range 1–3 years). Thus, the 30-day, institutional and one-year mortality were 58, 62 and 79%, respectively.

**Prognostic factors**

Nine patients were alive at the time of discharge and five patients at one-year follow-up. Age was not a prognostic factor for survival at these time points ($p = 0.056$ and 0.064). The length of bowel ischaemia was a negative prognostic factor for survival at these two time points ($p = 0.004$ and 0.005).

**Discussion**

The incidence of acute thromboembolic occlusion of SMA is difficult to quantify in the literature due to retrospective studies which include patients with different types of acute bowel ischaemia or of unknown aetiology. The exclusion of chronic bowel ischaemia in the present study explains why only 17% of the patients had a thrombotic occlusion. In contrast, one series from the Mayo Clinic included 43% with chronic bowel ischaemia, which increased the thrombotic occlusion-rate to 64%. The low autopsy rate indicates that the incidence may be underestimated in this and other studies.

There may be several explanations for the high mortality in our study. Each surgeon encounters only a few patients during his career. The elderly patient may present with unspecific symptoms and signs and advanced age may influence the surgeons’ decision to operate or whether to resect the gangrenous bowel. Even when the surgeon decided to operate at first evaluation, it took a median of five hours until laparotomy. This reflects either a lack of surgical decision-making or a misunderstanding of this condition among the anaesthetists. Some surgeons do not have the expertise required to undertake intestinal revascularization and need collaboration with a vascular surgeon.

In a recently published multi-centre study of 60 revascularized patients we reported favourable one-year results with a survival of 40% and a low
incidence of short bowel syndrome. This patient group, however, was selected: cardiac diseases were less frequent, the median age was 76 years, almost a decade younger than the six patients who underwent revascularization in this study. The prospective design resulted in a higher diagnostic and therapeutic activity as more patients were revascularized, but the outcome was less favourable. Moreover, the assessment of bowel viability, the decision to resect, to form a stoma or anastomosis and when to perform a second-look, are all demanding issues.

A history of previous peripheral artery embolism and synchronous emboli are well-known features. In our series, six patients had verified synchronous embolic events. This probably an underestimate since nine of the operated patients with fatal embolic disease did not have a post-mortem examination. Warfarin is underprescribed in patients with atrial fibrillation coming to a hospital. Pharmacotherapy 2000; 20: 1060–1065.

On admission, the fibrinolytic marker, D-dimer, had a high sensitivity for SMA-occlusion, consistent with the results of a previous study but evaluation of its specificity is awaited. CRP is helpful for decision-making in patients with acute abdominal pain and levels may be elevated within eight hours after the onset of various diseases. Most of our patients reached hospital within two hours, which explains why the CRP was normal or only slightly elevated upon arrival. Interestingly, blood-gas analysis more often showed alkalosis than acidosis, due to frequent vomiting in the early phase of bowel ischaemia.

All radiological imaging in our study resulted in diagnostic delay. Mesenteric angiography is a reliable diagnostic method and offers the opportunity to proceed with thrombolysis. This treatment option is promising since emboli that lodge in the periphery may be treated. If used in time, laparotomy may even be avoided, although a ‘check’ laparotomy is probably safer. Unfortunately, acute mesenteric angiography was seldom feasible at our hospital.

In conclusion, when the clinical triad or synchronous symptomatic embolic events are present the diagnosis of acute mesenteric ischaemia must be excluded, especially in elderly patients. An elevated D-dimer on admission had a high sensitivity for acute SMA occlusion and the extent of bowel ischaemia predicted survival.

References


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